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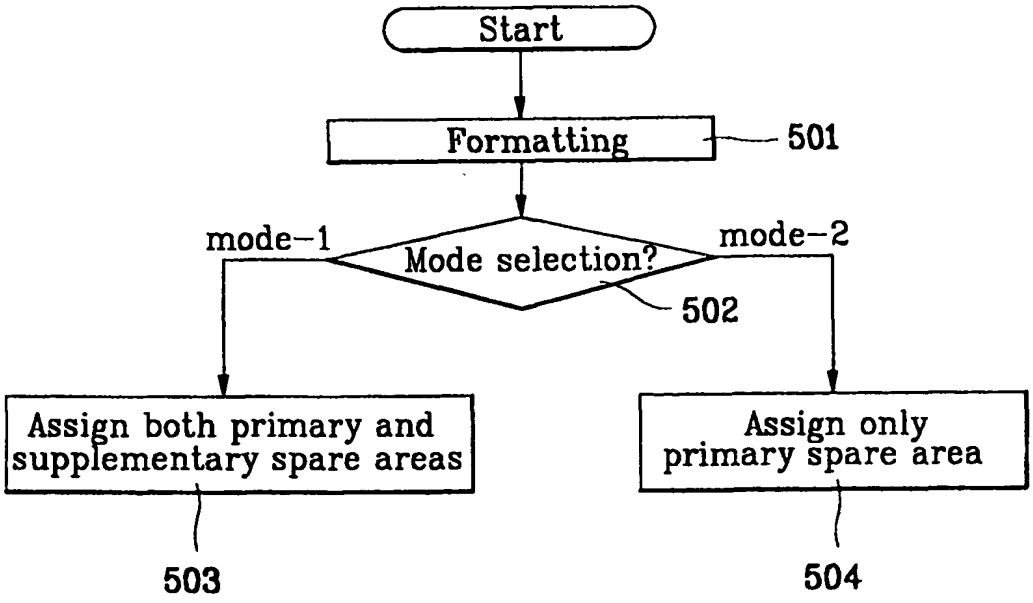

(57) Abstract

A rewritable optical recording medium and a method of assigning a spare area in the rewritable optical recording medium is disclosed. In the present invention, a primary spare area of optical discs, which have the same disc size and track pitch but different initial user sizes, are assigned to have a same size, thereby improving the compatibility of the discs.

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DESCRIPTION

Optical recording medium and method of assigning its spare area

Technical field

The present invention relates to a rewritable optical recording medium and a method of assigning the spare area in the rewritable optical recording medium.

Background Art

A rewritable optical recording medium generally includes a Rewritable Compact Disc (CD-RW) and a Rewritable Digital Versatile Disc (DVD-RW, DVD-RAM and DVD+RW). The rewritable optical disc performs repeated operations of recording and/or playback of the information on the disc. However, by the repeated operation, a mixture ratio of the mixture forming a recording layer for recording the information on the optical disc is changed from an initial mixture ratio thereof. Thus, the inherent characteristic of the optical disc is not maintained, thereby generating errors during the recording and/or playback of information. This is commonly known as degradation.

The area where degradation occurs is designated as a

defect area which appears upon the implementation of formatting, recording and/or playback commands of the optical disc. The defect area of rewritable optical discs may also be generated due to scratches on the surface, particles such as dust, and errors during manufacturing. Therefore, to prevent data from being recorded on or playbacked from defect areas of the optical disc, an effective management system for the defect area is necessary.

FIG. 1 shows a defect management area (DMA) in a lead-in area and a lead-out area of the optical disc to manage a defect area. Particularly, the data area is divided into a plurality of zones for the defect area management, where each zone is further divided into a user area and a spare area. The user area is where data is actually written and the spare area is used when a defect occurs in the user area.

There are four DMAs in one disc, e.g. DVD-RAM, two of which exist in the lead-in area and two exist in the lead-out area. Because managing defective areas is important, the same contents are repeatedly recorded in all four DMAs to protect the data. Each DMA comprises two blocks of 32 sectors, where one block comprises 16 sectors. The first block of the DMA, called a DDS/PDL block, includes a disc definition structure (DDS) and a primary defect list (PDL). The second block of

the DMA, called an SDL block, includes a secondary defect list (SDL). The PDL corresponds to a primary defect data storage and the SDL corresponds to a secondary defect data storage.

The PDL generally stores entries of defective sectors caused during the manufacture of the disc or identified when formatting a disc, namely initializing and re-initializing a disc. Each entry is composed of an entry type and a sector number corresponding to a defective sector. The SDL lists defective areas in block units, thereby storing entries of defective blocks occurring after formatting or defective blocks which could not be stored in the PDL during the formatting. Each SDL entry has an area for storing a sector number of the first sector of a block having defective sectors, an area for storing a sector number of the first sector of a block replacing the defective block, and reserved areas. Accordingly, defective areas, i.e. defective sectors or defective blocks, within the data area are replaced with normal or non-defective sectors or blocks by a slipping replacement algorithm and a linear replacement algorithm.

The slipping replacement algorithm is utilized when a defective area is recorded in the PDL. As shown in FIG. 2(a), if defective sectors m and n, corresponding to sectors in the user area, are recorded in the PDL, such defective sectors are

skipped to the next available sector. By replacing the defective sectors by subsequent sectors, data is written to a normal sector. As a result, the user area into which data is written slips and occupies the spare area in the amount equivalent to the skipped defective sectors. For example, if two defect sectors are registered in the PDL, data would occupy two sectors of the spare area.

The linear replacement algorithm is utilized when a defective block is recorded in the SDL or when a defective block is found during playback. As shown in FIG. 2(b), if defective blocks m and n, corresponding to blocks in either the user or spare area, are recorded on the SDL, such defective blocks are replaced by normal blocks in the spare area and the data to be recorded in the defective block are recorded in an assigned spare area.

As defective areas are compensated utilizing the spare area, methods of assigning the spare area plays an important role in the defective area management. Typically, the spare area may be allocated in each zone or group of the data area or may be allocated in a designated portion of the data area. One method is to allocate the spare area at the inner rings of a disc, i.e. at the top of the data area, as shown in FIGS. 3(a) and (b). In such case, the spare area is called a Primary

Spare Area. Namely, the data area excluding the primary spare area becomes the user area.

The primary spare area, assigned in an initial formatting process, is not given a logical sector number (LSN). Thus, the primary spare area is assigned when a manufacturer produces the optical disc or when a user initially formats an empty disc. A variety of sizes can be allocated for the primary spare area, depending upon an initial data recording capacity, i.e. the initial user area. For example, in order to provide a 4.7GB(Giga byte) initial data recording capacity (i.e. initial user area) in a disc with a size of 120mm, 26MB (Mega Byte) may be allocated for the primary spare area and maintain compatibility with DVD-ROM.

For purposes of explanation, a disc with an initial user area of less than 4.7GB as in FIG. 3(a) will be considered to be in a first mode and a disc with an initial user area of 4.7GB as in FIG. 3(b) will be considered to be in a second mode. For example, a disc in mode 1 may have a user area of 4.58GB and a primary spare area of 145MB.

Since the size of the primary spare area varies with the size of the initial user area as discussed above, the size of the primary spare area would vary depending upon whether a disc is in mode 1 or mode 2. In other words, although the

sizes and track pitches of the two modes may be identical, the initial sizes of the primary spare area would be different according to the initial user area size. This deteriorates compatibility between the two modes.

Disclosure of Invention

Accordingly, an object of the present invention is to solve at least the problems and disadvantages of the related art.

An object of the present invention is to provide an optical recording medium which assigns a primary spare area of the same size to mediums having different initial user area sizes.

Another object of the present invention is to provide an optical recording medium, in which a spare area is assigned during formatting in both the inner and outer rings of the optical recording medium depending upon a mode.

A further object of the present invention is to provide a method of assigning a spare area of an optical recording medium, in which both the primary spare area and secondary spare area are assigned or only the primary spare area is assigned during formatting, depending upon a mode.

A still further object of the present invention is to provide a method of assigning a spare area of an optical

recording medium in which conversions between modes is available.

Additional advantages, objects, and features of the invention will be set forth in part in the description which follows and in part will become apparent to those having ordinary skill in the art upon examination of the following or may be learned from practice of the invention. The objects and advantages of the invention may be realized and attained as particularly pointed out in the appended claims.

To achieve the objects and in accordance with the purposes of the invention, an optical recording medium according to the present invention has a data area divided into a user area and a spare area, in which initial primary spare areas of different optical recording media, having a same data area but different initial user sizes, have the same size.

Also, a method of assigning a spare area of an optical recording medium according to the present invention assigns, during formatting, a primary spare area in at least two modes, depending upon the desired user area size. One assigns the primary spare area in the inner ring of the recording medium and the other assigns both a primary spare area and a supplementary spare area in the inner and outer rings of the

recording medium respectively.

In the above method of assigning a spare area of an optical recording medium, the primary spare area is assigned to have the same size regardless of the mode. Also, conversion between the two modes is allowed.

Brief Description of Drawings

The invention will be described in detail with reference to the following drawings in which like reference numerals refer to like elements wherein:

Fig. 1 shows a structure of an optical disc in the related art;

Fig. 2(a) shows a slipping replacement algorithm in the related art;

Fig. 2(b) shows a linear replacement algorithm in the related art;

Figs 3(a) and (b) show examples in which a spare area is assigned at the top of the data area;

Fig. 4(a) shows an example of assignment of the spare area in a first mode according to the present invention;

Fig. 4(b) shows an example in which primary spare areas of two modes are assigned to have the same size according to the present invention;

Fig. 5 is a flow chart showing a method of assigning the

spare area of the optical recording medium according to the present invention; and

Fig. 6 shows a conversion process between the modes in the optical recording medium according to the present invention.

Mode for Carrying Out the Invention

Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings.

Generally, the present invention allows an assignment of primary spare area of the same size in discs of the same size and track pitch but different initial user area sizes, thereby improving the compatibility among different discs. For purposes of explanation, a disc with a size of 120mm (hereinafter "the disc") will be used to explain the present invention.

The disc may have an initial user area of 4.7GB and a primary spare area of 26MB, as discussed above. In such case, a primary spare area of 26MB would still be allocated to the 120mm disc with less than 4.7GB of an initial user area. The disc will be considered to be in a first mode when the initial user area is less than 4.7GB and in a second mode when the

initial user area is equal 4.7GB.

In the first mode, since a primary spare area of the same size is allocated while less initial user area than the first mode is assigned, a portion of the data area remains. This remaining portion will be referred as a secondary spare area. Particularly, the secondary spare area is equal to the total data area minus the sum of the user area and the primary spare area. For example, if the initial user area of the disc is 4.58GB, the total spare area would be 145MB as shown in FIG. 4(a) and if 26MB is allocated as the primary spare area, the size of the secondary spare area would be 119MB. The secondary spare area may be assigned as a supplementary spare area at the outer rings of a disc or near the bottom of the data area, as shown in FIG. 4(b).

The secondary spare area is assigned as the supplementary spare area simultaneously when the primary spare area is assigned. Namely, the primary and supplementary spare areas of the first mode may be assigned when the disc manufacturer fabricates the disc or when a user formats the disc. Similarly, the primary spare area of a disc in the second mode is assigned in the same way. However, the supplementary spare area of a disc in the second mode is assigned when necessary as data is recorded or playbacked from a disc.

Also, the primary spare area of a disc in either the

first mode or the second mode is not given a LSN, as discussed above. However, in the second mode, the LSN is not given to the supplementary spare area as well as the primary spare area. Particularly, the LSN is given to the user area of both the first and second modes.

Furthermore, for convenience of the user of a disc, either the manufacturer or the user can select between the first mode or the second mode, when a disc is formatted. Referring to FIG. 5, when formatting is selected (step 501), the manufacturer or user may select a mode (step 502). If the first mode is selected, both a primary and a supplementary spare areas would be assigned at the top and bottom of a disc, respectively (step 503). If the second mode is selected, only a primary spare area would be assigned at the top of the data area (504).

Thus, if the first mode is selected when formatting a disc, all three areas, i.e. a primary spare area, a supplementary spare area and a user area, would be assigned. For example, a primary spare area of 26MB, a user area of 4.58GB and a supplementary spare area of 119MB may be assigned to the disc. On the other hand, if the second mode is selected when formatting a disc, a primary spare area a user area would be assigned while a supplementary spare area may be assigned as necessary when recording or playing back data from a disc.

For example, a primary spare area of 26MB and a user area of 4.7GB would be assigned to the disc.

Moreover, the present invention allows a conversion between the first and second mode for further convenience of a user. This is possible because both modes have a primary spare area of the same size.

If a disc being used needs to be converted from the first mode to the second mode, the assignment of the supplementary spare area can be simply canceled through a formatting as shown in FIG. 6. For this conversion, the defect blocks registered in the SDL or only the defect sectors in the defect blocks registered in the SDL would be registered in the PDL. Also, a number of sectors within the primary spare area equivalent to the defect sectors newly registered in the PDL would slip into or become a part of the user area to maintain the initial user area. Once converted, the supplementary spare area may be assigned again as necessary when the primary spare area becomes full.

If a disc being used needs to be converted from the second mode to the first mode, a reverse process of a conversion from the first mode to the second mode is performed. Particularly, a primary spare area and a supplementary spare area are simultaneously accordingly assigned through formatting. Referring back to FIG. 4(a) and

(b), if the disc in the second mode has an initial user area of 4.58GB, 26MB would be assigned at the top of the data area as the primary spare area and 119MB would simultaneously be assigned as the supplementary spare area near the bottom of the data area. Also, similar to the conversion from the first to the second mode, defective blocks registered in the SDL or only the defect sectors in the defect blocks registered in the SDL would be registered in the PDL, and a number of sectors within the primary spare area equivalent to the defect sectors newly registered in the PDL would slip into or become a part of the user area.

As described above, in the method of assigning the spare area of the optical recording medium according to the present invention, the primary spare areas of discs in the first and the second modes are assigned to have the same initial size, improving compatibility between the two modes. Moreover, while the supplementary spare area of the first mode is assigned simultaneously with the primary spare area and the supplementary spare area of the second mode is assigned if required, a selection between the modes can be made through mode conversion when the disc is formatted. Finally, although a disc with a size of 120mm has been used for purposes of illustration, the present invention can be applied to any discs with the same disc size but different initial user area

sizes.

The foregoing embodiments are merely exemplary and are not to be construed as limiting the present invention. The present teachings can be readily applied to other types of apparatuses. The description of the present invention is intended to be illustrative, and not to limit the scope of the claims. Many alternatives, modifications, and variations will be apparent to those skilled in the art.

CLAIMS

1. A method of assigning a spare area of an optical recording medium having a data area comprising:

a first mode in which both a primary spare area and a supplementary spare area are assigned;

a second mode in which a primary spare area is assigned; and

assigning the spare area according to one of either the first mode or the second mode when the optical recording medium is formatted.

2. A method of claim 1, wherein a size of the primary spare area of the first and second modes are equivalent.

3. A method of claim 1, wherein a size of the primary spare area in the first mode is determined based upon a size of the primary spare area in the second mode.

4. A method of claim 1, wherein a size of the supplementary spare area in the first mode is determined by subtracting a size of the primary spare area and a size of a user area from the data area size of the optical recording medium.

5. A method of claim 1, wherein the second mode further

comprises assigning a supplementary spare area as necessary while data is recorded in and/or playbacked from the optical recording medium.

6. A method of claim 1, wherein the primary spare area in the first and second mode is assigned at the top of the data area of the optical recording medium.

7. A method of claim 1, wherein the supplementary spare area in the first mode is assigned near the bottom of the data area of the optical recording medium.

8. A method of claim 1, wherein the supplementary spare area in the first mode is assigned without a LSN.

9. A method of claim 1, wherein assigning the spare area according to one of either the first mode or the second mode based upon a selection by a user or a manufacturer.

10. A method of claim 9, wherein a size of the primary spare area of the first and second modes are equivalent.

11. A method of claim 10, further comprising converting from the first mode to the second mode if the first mode was selected

or converting from the second mode to the first mode if the second mode was selected, based upon a selection by a user or a manufacturer.

12. A method of claim 11, wherein a conversion further comprises registering one of either defect blocks registered in a SDL or only defect sectors in defect blocks registered in the SDL of the optical recording medium in a PDL of the optical recording medium.

13. A method of claim 11, wherein the first mode is converted to the second mode by canceling the assigned supplementary spare area when formatting the optical recording medium.

14. A method of claim 11, wherein the second mode is converted to the first mode by assigning both the primary spare area and the supplementary spare area when formatting the optical recording medium.

15. An optical recording medium having a data area in which a spare area is assigned by the method of claim 1.

16. An optical recording medium of claim 15, wherein the

spare area is assigned according to one of either the first mode or the second mode based upon a selection by a user or a manufacturer.

17. An optical recording medium of claim 16, wherein a size of the primary spare area of the first and second modes are equivalent.

18. An optical recording medium of claim 1, wherein the primary spare area in the first and second mode is assigned at the top of the data area of the optical recording medium.

19. An optical recording medium of claim 15, wherein the supplementary spare area in the first mode is assigned near the bottom of the data area of the optical recording medium.

FIG.1

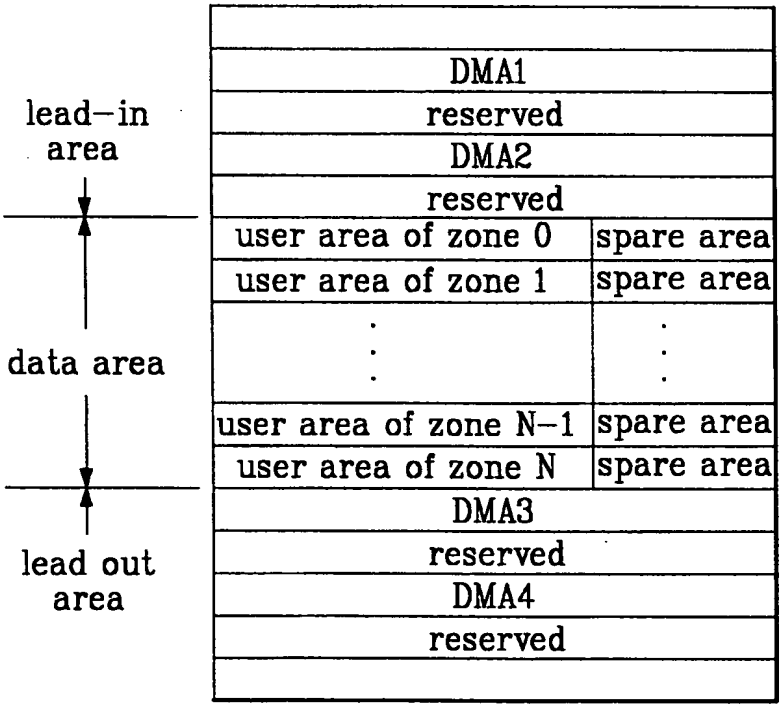
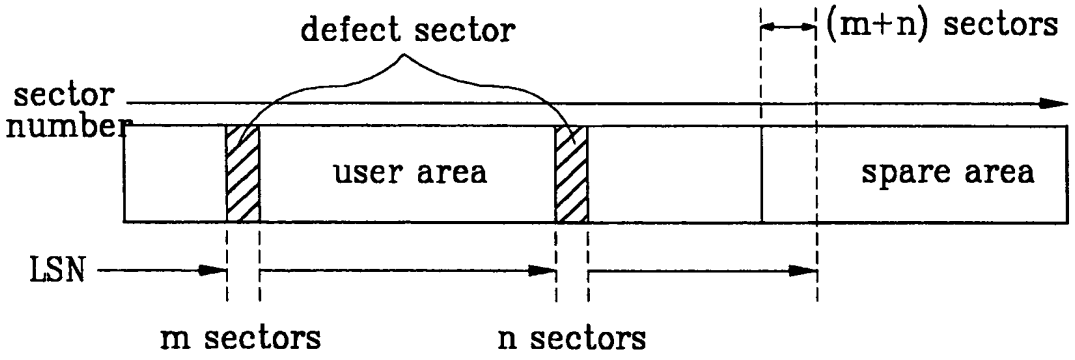

lead-in area
data area
lead out area
DMA1
reserved
DMA2
reserved
user area of zone 0
spare area
user area of zone 1
spare area
user area of zone N-1
spare area
user area of zone N
spare area
DMA3
reserved
DMA4
reserved

FIG.2

(a)


defect sector
(m+n) sectors
sector number
user area
spare area
LSN
m sectors
n sectors

(b)

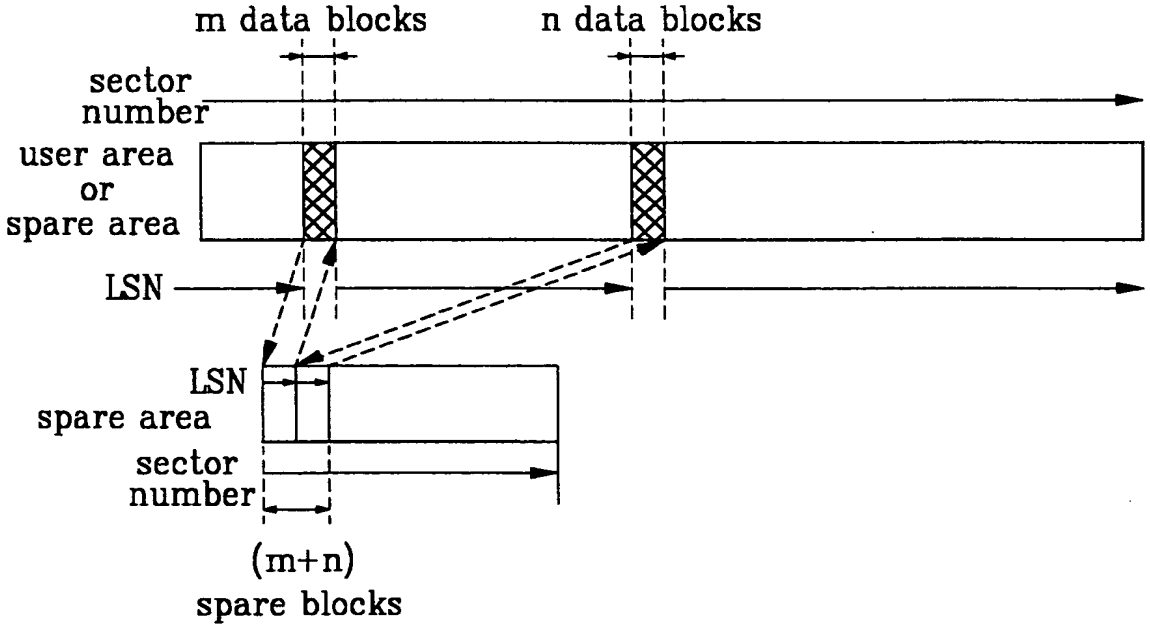

m data blocks
n data blocks
sector number
user area or spare area
LSN
LSN
spare area
sector number
(m+n) spare blocks

FIG.3

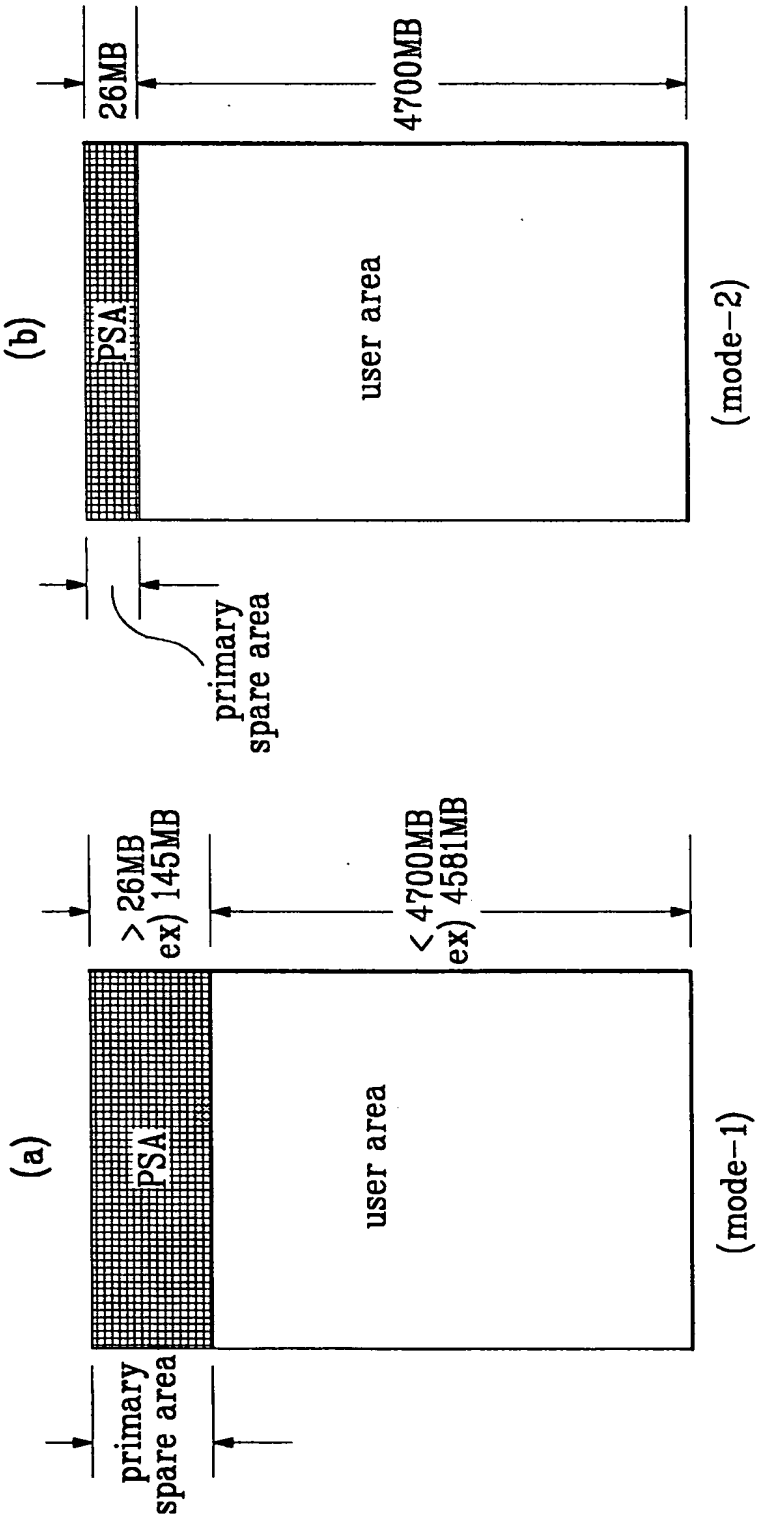

(a)
primary spare area
PSA
> 26MB ex) 145MB
user area
< 4700MB ex) 4581MB
(mode-1)
(b)
primary spare area
PSA
26MB
user area
4700MB
(mode-2)

FIG. 4

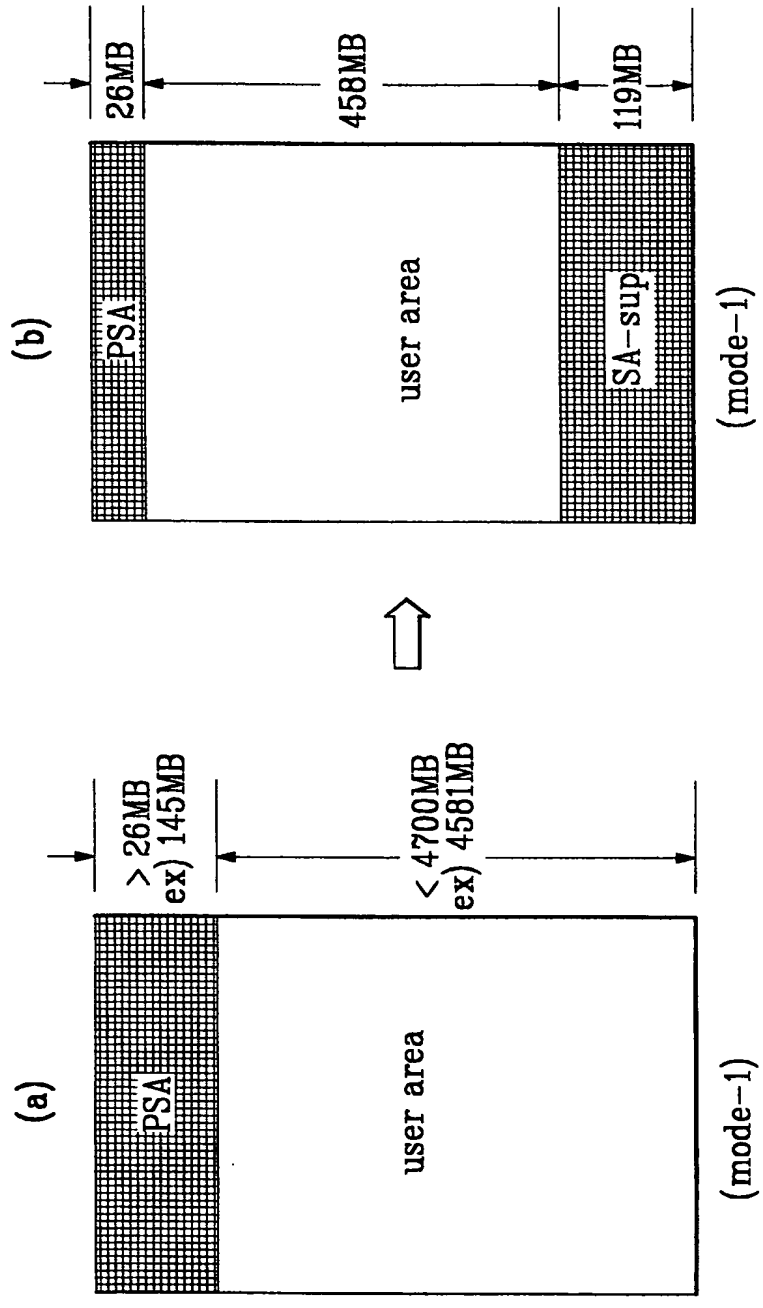

(a)
PSA
> 26MB
ex) 145MB
user area
< 4700MB
ex) 4581MB
(mode-1)
(b)
PSA
26MB
user area
458MB
SA-sup
119MB
(mode-1)

FIG. 5

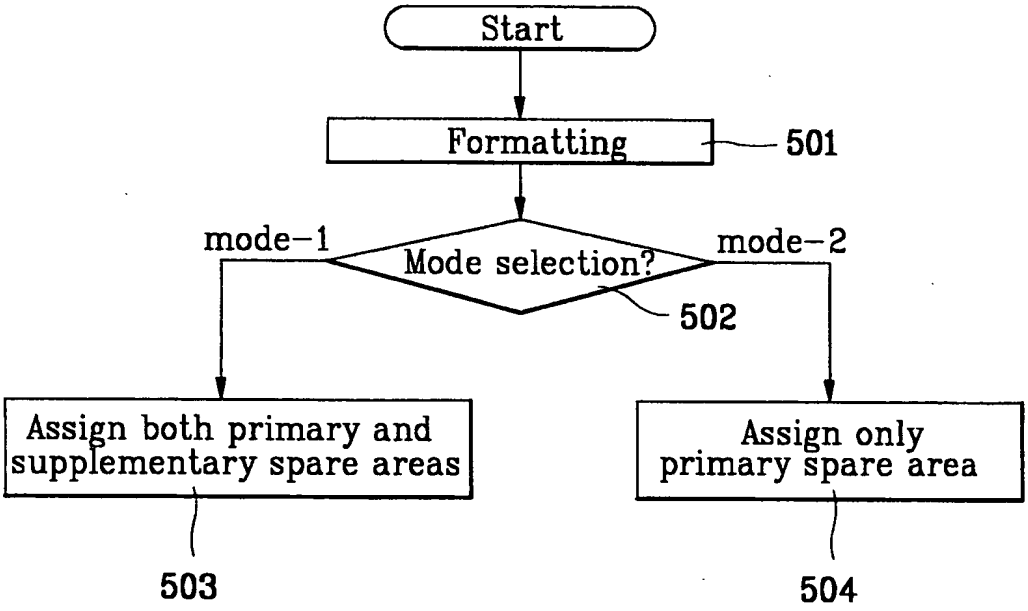
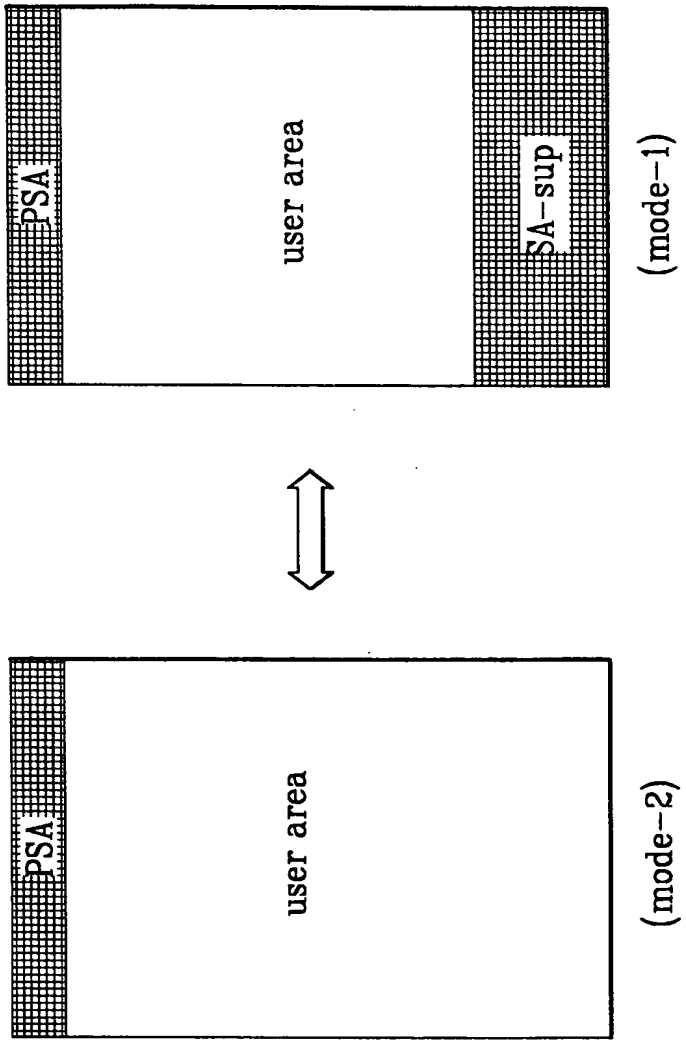

Start
Formatting
501
mode-1
Mode selection?
mode-2
502
Assign both primary and supplementary spare areas
Assign only primary spare area
503
504

FIG.6



INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR 99/00688

A. CLASSIFICATION OF SUBJECT MATTER

IPC[7]: G 11 B 20/12, 7/00, 20/10, 27/00, 20/18, 7/007

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC[7]: G 11 B 20/00, 7/00, 27/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A,P	GB 2326015 A (LG ELECTRONICS INC.) 09 December 1998 (09.12.98), abstract; fig. 1.; claims 1-3; page 1, line 20 - page 5, line 9.	1-19
A	JP 09-251721 A (MITSUBISHI ELECTRIC CORP.), (abstract) 30 January 1998 (30.01.98), In: Patent Abstracts of Japan [CD-ROM].	1-19
A	EP 0350920 A2 (MATSUSHITA ELECTRIC IND. CO) 17 January 1990 (17.01.90), abstract; fig. 1; claim 1; page 3, line 1 - page 5, line 24.	1-19

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
19 January 2000 (19.01.00)	29 March 2000 (29.03.00)
Name and mailing adress of the ISA/AT Austrian Patent Office Kohlmarkt 8-10; A-1014 Vienna Facsimile No. 1/53424/200	Authorized officer Berger Telephone No. 1/53424/453

Form PCT/ISA/210 (second sheet) (July 1998)

INTERNATIONAL SEARCH REPORT

Information on patent family members

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